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Rice vs. Wheat: Does staple food consumption pattern affect food waste in Chinese university canteens?

Abstract

Emerging economies, particularly China, are likely to play a critical role in determining global food waste. The paper investigates plate waste from a staple food consumption pattern perspective by surveying 9,192 Chinese university students at the on-campus canteens in 29 provinces of mainland China. A significant finding is that diet culture is closely related to food waste. Southerners who consume rice as a staple food are found to waste more food than Northerners who are wheat-based eaters on average. A robust test confirms the finding when matching the student's hometown and university location and setting the "Southerners studying in South China" as the reference group. Taking into account the possible self-selection problem, the robustness test based on the PSM model also confirms the association between staple food consumption patterns and food waste in Chinese university canteens. Comparative analyses based on the components of food consumption and the compositions of wastage further suggest that the differences in staple food consumption patterns determine the food wastage variations. This study provides empirical evidence that differences in consumption patterns bring about the disparity in food wastage within a country.

Highlights

- The difference in diet culture between North China and South China is mainly reflected in staple food consumption patterns.
- Southerners who consume rice as the staple food are found to waste more than Northerners who are wheat-based eaters in Chinese university canteens.
- This study provides empirical evidence that differences in staple food consumption patterns bring about the disparity in food wastage within a country.
- The examination is based on nationwide food waste survey data.

1. Introduction

In the 21st century, hunger is still one of the biggest challenges faced by individuals worldwide. About 821 million people worldwide did not have enough food in 2017, which means one out of every nine worldwide is starving (FAO et al., 2018). The situation deteriorated during the pandemic period in 2020 due to trade and logistics restrictions. While hunger still rages globally, a large amount of food is wasted every year. Lipinski et al. (2013) suggest that about 32% of edible food suitable for human consumption is wasted. The Food Waste Index Report 2021 recently released by United Nations Environment Programme (UNEP, 2021) gives a lower estimate and finds that 17% of total global food production is wasted at the consumer level. If the food wasted could be used effectively, it will significantly reduce the number of people affected by hunger. Thus, the UN Sustainable Development Goal of "zero hunger in the world" could become a reality (United Nations, 2020).

Food waste also brings a massive waste of resources and economic losses, and significant adverse environmental effects (Tonini et al., 2018). Wasting food is equivalent to wasting water, energy, and other resources that can be used to producing food (Song et al., 2018). In addition, when the food is collected, transported to, and degrades in landfill sites, it becomes a substantial source of methane gas emissions, contributing to climate change (FAO et al., 2018). Recent studies show that, in the absence of policy

interventions or behavioral change, global calories wasted will nearly double by 2050 (Barrera and Hertel, 2021). In addition, per capita food waste is predicted to increase by 72%, reaching 812 kcal per capita per day (Barrera and Hertel, 2021). Emerging economies, particularly China, are likely to play a critical role in determining global food waste at mid-century (UNEP, 2021).

Food waste means that under current conditions, the part that could be eaten by people is discarded in vain (FAO, 2013). Therefore, reducing food waste has attracted attention from academia in recent years. There are diversified driving forces behind the food-wasting phenomenon due to the complexity of human beings' decision-making process (Bravi et al., 2020). For example, existing literature indicates that individual characteristics (Parizeau et al., 2015; Visschers et al., 2016), such as demographic and economic factors (Bravi et al., 2020; Ilakovac et al., 2020), social rules or morality, perceptions, and attitudes (Falasconi et al., 2019), dining circumstance (Lam et al., 2010; Wang et al., 2017), awareness campaigns (Pinto et al., 2018; Whitehair et al., 2013), and other factors may correlate with food wastage. Despite the growing literature on food waste, there is a substantial lack of knowledge of food-wasting patterns.

Given that food waste during the consumption stage is more likely to occur in high-income countries, the existing literature is mainly from the developed countries, such as the United Kingdom (Tonini et al., 2018), the United States (Buzby and Hyman, 2012), German (Jörissen et al., 2015), Spain (Derqui et al., 2018), Italy (Falasconi et al., 2019), Canada (Parizeau et al., 2015), Sweden (Rousta et al., 2015), and Australia (McCarthy and Liu, 2017). However, food waste research on emerging economies is scarce (Aschemann-Witzel et al., 2019). With the rapid economic development and the improvement of people's living standards, food waste issues are occurring and becoming critical in China due to the size of its economy and population (Bai et al., 2016; Liu et al., 2013a; Song et al., 2018). Nevertheless, research on Chinese consumers' food wastage is still rare (Xue et al., 2017; Min et al., 2021).

Previous studies suggest that food-wasting happens in multiple places, including households sectors (Min et al., 2021; Rousta et al., 2016), restaurants (Wang et al., 2018; Xu et al., 2020), hospitals (Zakiah et al., 2005), elementary and middle schools (Liu et al., 2013b; Liu et al., 2016), and university canteens (Ellison et al., 2019; Wu et al., 2019). University canteens are a recent focus of scholarly attention because the university is a unique community composed of youth with a high level of education that has a moral responsibility to reduce waste and move towards sustainable development (Derqui et al., 2018; Wu et al., 2019). The implications of reducing plate waste gained from the university campus may be helpful for other communities (Wilkie et al., 2015). The existing literature includes the surveys of 540 university students at Kansas State University in the USA (Whitehair et al., 2013) and 205 university students from Rhodes University in South Africa (Painter et al., 2016); the investigations at the Lisbon University in Portugal (Pinto et al., 2018), Ghent University in Belgium (Schaubroeck et al., 2018), and a university in Qatar (Abdelaal et al., 2019). However, similar research in developing countries is still rare.

According to the latest data from the Ministry of Education of China (MEC), there are currently 2,956 universities/colleges in mainland China, and the number of university students nationwide has reached 37.535 million in 2019 (MEC, 2020). Given the massive scale, it is crucial to understand the influential factors affecting the cohort's food consumption behavior before discussing food waste reduction policies. In contrast to their Western counterparts, most Chinese university students live and dine on campus, so the university canteen is ideal for carrying out the investigations. Therefore, in-depth research on food waste at Chinese university canteens is needed. The only research is Wu et al. (2019), who surveyed 551 university students at six universities in Beijing, China. Given China's size and regional diversification in economic development and diet pattern, national-level research is needed to reduce the bias caused by a small sample. As far as we know, nearly no studies have used a national-wide survey to focus on food waste among university students as we did. This research obtained 9,192 samples from 29 universities in 29 provinces of mainland China.

It should be pointed out that Qian et al. (2021) has conducted a preliminary analysis on the food wastage of Chinese university students using the same data, but their study is mainly descriptive analyses and lacks a unique perspective. As China is a big country with various food patterns, this paper investigates whether the diet culture affects the food-wasting behavior of Chinese university students. Previous cross-national studies find that dietary structure variations may significantly influence food wastage in different countries (Secondi et al., 2015; Ferk et al., 2018). However, these studies are mostly speculative, and no studies have given convincing verification and empirical evidence before. Nevertheless, it is valuable to understand food consumption patterns' impact to form effective food waste policies.

The differences in staple food consumption patterns between South and North China are prominent. Divided by Qinling (Mountains)-Huaihe (River) Line[1], rice cultivation is situated in the South; wheat cultivation is located mainly in the North (Talhelm et al., 2014). Consequently, Southerners' staple food is rice-based, while Northerners consume wheat-based products as their staple food. And the difference in staple foods is often regarded as the core manifestation of the difference in dietary culture between the north and south (Dong et al., 2019). Therefore, based on 9,192 samples from 29 universities in 29 provinces of mainland China, this study is very interesting in exploring the association between the staple food consumption pattern and food wastage. Previous studies also show that many factors may cause university students to waste food in canteens (Painter et al., 2016; Whitehair et al., 2013; Wu et al., 2019). Therefore, the paper also aims to answer that what other factor that impacts the food wastage of Chinese university students.

The paper mainly makes two contributions to the body of literature. First, it is common sense that the difference in diet culture between the north and south of China is mainly reflected in staple foods. However, nearly no studies have rigorously verified this judgment. Whether this judgment is valid is the prerequisite for the subsequent analysis of this paper. To the best of our knowledge, the paper provides the first verification on diet culture in China and it is confirmed that Southerners are rice-based eaters, while Northerners are wheat-based eaters. Second, this paper is among the first attempts to analyze the association between dietary culture and food waste systematically within a country. Take China as an example, this paper provides evidence that regional diet culture differences within a country affect individual food wastage, which has some enlightenment for reducing food waste in Chinese university canteens. It also provides a base for scholars in other countries to explore how the regional differences in diet culture impact food waste, especially for those countries with diversified staple food patterns. Moreover, several studies have confirmed that the rice versus wheat divergence in the north and south of China is not a simple natural phenomenon, and it has a significant impact on the economic and social behavior of individuals (Talhelm, 2020; Zhang et al., 2021). This paper is also helpful to expand the scope of research in this field.

2. Methodology

2.1. Data sources and collection

To explore Chinese university students' food-wasting behavior, we conducted a large-scale survey in mainland China in 2018[2]. First, considering the regional dietary pattern differences in China, we carried out a pilot survey at two universities locating in South and North China. Then, the questionnaire was revised and improved according to the feedback.

We planned to survey 30 universities in 30 provinces of mainland China, except for Tibet, to ensure better coverage and representativeness. One university was chosen in each of the 30 provinces. There are three steps to choose a specific university surveyed. The first step is to list all the universities in the provinces surveyed. The second step is to rank the universities from large to small according to the number of students enrolled. The third step is to select a university from each province randomly. Unfortunately, we failed to complete the survey in Henan province due to unforeseen circumstances. As a result, the data collection finally involved 29 universities in 29 provinces in mainland China (Fig. 1).

Fig. 1. List of the surveyed universities in China.

The questionnaire consists of two parts[3]: the first part is background information, including individual socio and demographic characteristics, family-level features, catering characteristics, regional factors; the second part includes information about the composition and weight of food wastes. Food waste is grouped into ten basic raw categories[4]: rice, wheat, pork, beef and mutton, poultry, aquatic products, egg products, soy products, vegetables, and fruits, following the previous practice (Qian e al., 2021; Wang et al., 2017). These foods are prevalent in Chinese universities, and they are also the main food items in the daily diet of Chinese people.

To obtain good quality samples as many as possible, broader coverage, and strong representativeness, we set the minimum sample size to 300 in the universities surveyed. For universities with a more significant number of students, the minimum sample size is set to 350. On average, 11 students were recruited in each university to be responsible for the investigation, including one supervisor and 10 investigators. They were recruited and trained to carry out a random sample of 300-350 surveys in each university[5]. The investigator only approached the university student after the meal to reduce the possible bias and behavioral changes caused by the study's awareness. In each university, the trained investigators conducted surveys from Monday to Sunday to capture potential daily food waste variances (Wang et al., 2017). The students

surveyed were random selected during the investigation that had the willingness to cooperate with the investigators. To avoid duplication, our trained investigators strictly abide by the procedures in the investigation process. The respondent will be first asked whether they have participated in our investigation on food waste before. If they have participated before, the investigator will inform them that they cannot participate again. As a considerable proportion of university students do not eat breakfast in canteens, the survey only involved lunch and dinner, which is consistent with the investigation on food waste at Stellenbosch University (Marais et al., 2017) as well as a study at Kansas State University (Whitehair et al., 2013). Finally, through the joint efforts of 29 supervisors and 290 trained investigators, we obtained 9192 valid samples.

2.2. Food waste measurement and accuracy

Obtaining an accurate assessment of food waste data for university students eating in canteens is a challenge. Firstly, it is necessary to clarify the food waste definition. There are different food waste definitions in the literature (Thyberg and Tonjes, 2016; Xue et al., 2017). Following the Food and Agriculture Organization of the United Nations (FAO), this paper identifies food waste as the edible part discarded by people, which can be avoided under existing conditions; however, the inedible parts which are not fit for consumption, such as vegetable peelings, eggshells, and fish bones, are not included (FAO, 2013). Moreover, this paper only deals with food wastage generated during the consumption stage. Food waste during the food preparation stage in canteen kitchens is not considered in this paper. Food waste is limited to solid waste in this survey, not including liquids such as soups, drinks, cooking oil, and milk, which is in line with previous surveys (Whitehair et al., 2013).

Secondly, it is vital to determine the method adopted to obtain food waste data. Many studies use secondary data and a self-reported approach (Ammann et al., 2021; Stancu et al., 2016; Young et al., 2018). Also, visual estimation and the digital photography method are employed in some research (Lorenz et al., 2017). However, few researchers choose to use the direct weighing method (Painter et al., 2016) because it is time-consuming and labor-intensive. However, the advantage is data accuracy (Li et al., 2021; Xue et al., 2017). Therefore, this paper finally adopts the direct method to secure data as accurately as possible. Following Derqui and Fernandez's (2017) practice, the investigators arrived at the surveyed canteens one hour before lunch or dinner time. Thus, they had enough time to complete the preparations: purchasing all the canteen's meals, classifying the food components, and weighing them with electronic scales to get the standard weight for each category. Since each type of food provided in a canteen is standardized, it is easy to get the total standard weight by summing the food item weight that the individual has purchased (Visschers et al., 2016; Wang et al., 2017).

After the student has finished his/her meal, the investigator firstly obtained the survey participant's consent. Once permission was granted, the respondent's personal information was sought and recorded. Next, the investigator collected and classified the wasted food of each respondent. The leftovers were divided into ten items, as mentioned previously. Next, the food waste was classified and weighed with electronic scales to improve data accuracy. Two investigators cooperated to complete the weighing and data recording process. One investigator was responsible for cleaning the remaining plates, sorting, and weighing. The other investigator supervised the above process and gave necessary reminders, and was responsible for filling the questionnaire with the wasted data for each type of food item. Finally, the total weight of the food waste was obtained by summing up each food component's weight. Our trained investigators weighed more than 30,000 individual leftover food items in nearly two months and obtained valid questionnaires from 9192 university students.

It should be mentioned that to obtain more accurate first-hand data on food waste as much as possible, the electronic scale equipped in this survey was the JJ500 type of the Shuangjie brand with an accuracy of 0.01g, which can achieve a high-precision display of 1/10000. Therefore, the data used in this paper is more

accurate than those of existing studies, with an accuracy of 1g or 0.1g, such as Wang et al. (2017) and Wu et al. (2019).

Food waste is the explanatory variable of this paper, which is measured in two dimensions. The first one is the total weight of food waste after the meal. Unlike most studies that use the overall weighing method, this paper obtains food waste data by summing all wasted food components to reduce bias (Qian et al., 2021). The second one is the food waste ratio for the meal, which indicates the severity of food wastage. The plate waste ratio is calculated by the weight of food waste dividing by the total standard weight.

2.3. Staple food consumption pattern

The staple food consumption pattern is the critical explanatory variable of this paper. Earlier studies indicate that dietary structure, to some degree, leads to various food wastage modes among residents from different countries (Secondi et al., 2015; Ferk et al., 2018). Given that China is a vast and populous country, its food consumption patterns vary regionally. One of the most substantial differences is that Southerners are rice-based eaters; Northerners are wheat-based eaters (Qian et al., 2021). The traditional cultivated area of rice is Southern China, while Northern China is the traditional wheat-growing area (Talhelm et al., 2014; Talhelm, 2020). It is food availability and proximity that determine the differentiation. Since it is difficult to change eating habits, their family address can better demonstrate the differences in staple food consumption patterns between North and South.

When asked whether a person is a southerner or a northerner in China, it is usually defined according to the province where the respondent's family lives[6]. However, this has led to some provinces with both southerners and northerners, such as Anhui, Jiangsu. Therefore, to show the differences in staple food consumption patterns more accurately, this study uses Qinling Mountains and Huaihe River as the boundary to identify whether a university student is a southerner or a northerner (Chen et al., 2013). It is also the rice and wheat cultivation geographical boundaries in China (Dong et al., 2019; Zhang et al., 2021). If the respondent's family address locates in the South of Qinling–Huaihe boundary, then it can be assumed that the respondent is a southerner who is rice-based, and the value is 1. Otherwise, the respondent is a northerner who is wheat-based, and the value is 0.

2.4. Control variables

Follow existing studies on university students' food waste in China (Painter et al., 2016; Qian et al., 2021; Wu et al., 2019), three influencing group factors are introduced as controlled variables, including catering features, individual-level, and family-level characteristics.

This paper considers six variables for catering features, including the dummy variables of lunch or dinner, time pressure, presence of others, plate size, the difference in how food is served, and food taste satisfaction. The reasons for introducing the above variables are as follows. Firstly, previous studies indicate that university students' food-waste behavior is different between lunch and dinner (Lorenz et al., 2017; Marais et al., 2017; Painter et al., 2016). Secondly, existing studies support that others' presence may affect plate waste when ding in canteens (Lee et al., 2012; Wu et al., 2019). Thirdly, it is argued that one of the reasons for wasting food outside of the home is the oversupply of food (Bai et al., 2016; Lorenz et al., 2017); thus, the plate size is regarded as a control variable. Fourthly, it is suggested that differences in how food is served may affect food wastage in university canteens (Thiagarajah and Getty, 2013). Fifthly, we cannot ignore the impact of individuals' subjective evaluation on food taste. In general, if the students are more satisfied with the meal, less food is wasted (Lam et al., 2010).

This paper introduces seven variables at the individual level, including gender, age, ethnicity, education, Body Mass Index (BMI), only child status and food waste knowledge. Previous studies have shown that individuals with different genders (Al-Domi et al., 2011; Painter et al., 2016), ages (Secondi et al.,

2015; Thyberg and Tonjes, 2016), ethnicity, education levels (Mattar et al., 2018; Wu et al., 2019) may have differences in food wastage, so these variables are controlled. Previous studies have also suggested that young people are very concerned about their figures, which may affect food wastage (Hawkins et al., 2020), so the individual BMI is introduced as a control variable. A popular perception is that somebody who is the only child of a family is more likely to waste food than somebody who has siblings in China (Jiang et al., 2018). Thus we introduce an "Only child of a family" dummy variable. In addition to the above objective characteristics, the impact of waste knowledge on reducing food waste or information intervention is considered as suggested by the previous study (Whitehair et al., 2013; Young et al., 2017, 2018).

For family characteristics, household size (Falasconi et al., 2019; Parizeau et al., 2015; Stancu et al., 2016), and the family economic conditions (Abdelradi, 2018; Wu et al., 2019) are included according to the literature.

Besides, given that China is a large country with different economic development levels, eastern China is the most economically developed region, followed by central China, and western China is relatively underdeveloped. Therefore, two regional dummies are introduced to distinct East, Central, and West China.

The definition and statistical analysis of all the variables used in this study are presented in Table 1.

Table 1. The definition and statistical analysis of variables.

Variable	Definition	Mean	St. Dev.
Weight of food waste	Total weight of plate waste for the meal, (g)	61.03	73.71
Food waste ratio	Food-wasting rate for the meal, (%)	12.13	14.55
Staple food consumption pattern	1 = southerners who are rice-based eaters, 0 = northerners who are wheat-based eaters	0.54	0.50
Gender	1 = male,0 = female	0.52	0.50
Age	Age=2018-year of birth	21.25	2.33
Ethnicity	1 = Han,0 = minority	0.90	0.30
Education	1 = postgraduate,0 = undergraduate	0.19	0.39
BMI	BMI: weight(kg)/square of height(Meter)	20.68	2.81
Only child of a family	Whether the respondent is the only child of family:1 = yes,0 = no	0.43	0.40
Food waste knowledge	Whether familiar with the disadvantages of wasting food: 1 = yes,0 = no	0.41	0.49
Household size	1 = 3 people and below,2 = 4-6 people, 3 = 7 people and above	1.67	0.53
Family economic condition	The monthly living expenses of respondents: 1 = less than 1000 Yuan, 2 = 1001-1500 Yuan, 3 = more than 1500 Yuan	1.74	0.76
Lunch or dinner	1 = lunch-time,0 = dinner-time	0.55	0.50
Time pressure	The duration of the meal: 1 = more than 30 min,2 = 16-30 min, 3 = less than 15 min	1.55	0.57
Presence of others	1 = eating with others, 0 = eat alone	0.63	0.48
Plate size	The standard weight of the meal,(g)	524.54	155.38
Difference in how food is served	1 = staple food and additional foods together on a single plate,0 = staple food accompanied by additional foods on separate plates	0.66	0.47
Food taste satisfaction	1 = less satisfied; 2 = generally satisfied; 3 = more satisfied	2.40	0.59
Eastern China	whether it is a university in eastern China:1 = east; 0 = non-east	0.41	0.49
Central China	whether it is a university in central China: 1 = central; 0 = non-central	0.21	0.41

2.5. Econometric models

To investigate the factors affecting Chinese university students' food-wastage, and inspired by prior studies (Qian et al., 2021; Wu et al., 2019), the basic econometric model of this analysis is introduced as below:

$$Food - waste_i = \beta_0 + \beta_1 SN + \sum g_i X_i + \varepsilon_i$$

Among them, Food-waste$_i$ indicates the food waste generated by university student i. SN is an explanatory variable, meaning whether an individual is a southerner or Northerner to denote the staple food consumption pattern. X_i represents a series of control variables, including individual characteristics; family features, catering characteristics, and regional factors. ε_i is the random error. β_0 denotes a constant, β_1 is the coefficient of the core explanatory variable, and g_i represents the corresponding coefficients of a series of control variables. Therefore, this article mainly uses the interpretation of β_1 (including the significant level, the direction, and marginal effects) to identify the association between the staple food consumption pattern and individual food waste.

This paper employs the Tobit model, following Mattar et al. (2018) and Falasconi et al. (2019). Since the explained variables, namely, the weight of food waste and food-wasting ratio, are non-negative indicators greater than zero, which do not satisfy the normal distribution conditions, it usually needs to be processed by a truncated model.

3. Results

3.1. Descriptive analysis

Descriptive analysis with the two sample t-test is firstly performed, and the results are listed in Table 2. It is shown that Southerners whose staple food is rice-based (68.56 g) waste more food per capita per meal than Northerners whose staple food is wheat-based (53.88 g), which has passed the t-test at the 1% significance level. And for the average food waste ratio per capita per meal, Southerners (about 13 %) also have a higher average value compared with Northerners (about 10 %), and the difference between the two groups also passed the t-test at the 1% significance level. Therefore, the t-test used for group analysis preliminary showed that the difference in staple food consumption patterns between the South and North associates with individual food wastage in Chinese university canteens.

Table 2. Staple food consumption pattern and food waste: A two sample t-test.

Food waste	**Group**	**Mean (SD)**	**t**	**df**
Weight of food waste (g)	Southerners who are rice-based eaters	68.56 (78.84)	-9.56***	9,126
	Northerners who are wheat-based eaters	53.88 (67.74)		
Food waste ratio (%)	Southerners who are rice-based eaters	13.25 (0.24)	-12.03***	9,119
	Northerners who are wheat-based eaters	10.15 (0.19)		

Note: * $p < 0.1$,** $p < 0.05$,*** $p < 0.01$. The values appearing in parentheses are standard deviations (SD); df means degrees of freedom.

3.2. Benchmark regression

To further verify the influence of north-south staple food difference on university students' food wastage, according to Eq. (1), the benchmark regression is performed, and the results are presented in Table 3. The LR chi2 and Pseudo R^2 suggest that the regression equation fits well. The results show that the staple food consumption pattern and individual food waste are significantly positively correlated. University students from South China whose staple food is rice-based have a more considerable weight of food wastage than their North peers who are wheat-based eaters. Also, the average ratio of food waste per capita per meal for

the Southerner is higher than the Northerner. The marginal effect shows that the average amount of plate waste per capita per meal for Southerners is 17.10 grams higher than Northerners. And the average food-wasting rate for Southerners who are rice-based eaters is about 3.5% higher than that of Northerners who consume wheat as their staple food. Therefore, it is concluded that the rice versus wheat divergence plays a critical role in individual food wastage.

Table 3. Staple food consumption pattern and food waste: Benchmark regression.

Variable	**Explained variable Weight of food waste (g) Food waste ratio (%)**	
Staple food consumption pattern	17.10***	3.45***
	(2.06)	(0.41)
Gender	-29.55***	-5.95***
	(2.19)	(0.43)
Age	0.73	0.19
	(0.63)	(0.13)
Ethnicity	2.83	0.45
	(3.37)	(0.67)
Education	-7.64**	-2.00***
	(3.73)	(0.74)
BMI	-2.47***	-0.48***
	(0.39)	(0.08)
Only child of a family	0.61	0.22
	(2.83)	(0.56)
Food waste knowledge	-5.05**	-0.84**
	(2.06)	(0.41)
Household size	2.88	0.46
	(2.62)	(0.52)
Family economic condition	6.65***	1.38***
	(1.38)	(0.27)
Lunch or dinner	4.55**	0.78*
	(2.04)	(0.40)
Time pressure	1.76	0.40
	(1.80)	(0.36)
Presence of others	2.87**	0.51**
	(1.30)	(0.26)
Plate size	0.14***	0.01***

Variable	Explained variable Weight of food waste (g)	Food waste ratio (%)
	(0.01)	(0.00)
Difference in how food is served	3.64*	0.82*
	(2.15)	(0.43)
Food taste satisfaction	-19.70***	-3.69***
	(1.71)	(0.34)
Eastern China	13.60***	2.60***
	(2.40)	(0.47)
Central China	-2.81	-0.62
	(2.71)	(0.54)
Constant	28.25	16.00***
	(17.66)	(3.50)
sigma	87.29***	17.32***
	(0.83)	(0.17)
LR chi^2	946.49***	608.68***
Pseudo R^2	0.012	0.011
Observation	8,157	8,166

Note:*$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The values appearing in parentheses are standard errors.

When explaining that universities in South China waste food more than universities in North China, Qian et al. (2021) proposed a hypothesis that this is probably due to the difference in diet culture between the north and the south. Therefore, this conjecture has been verified in this study, which means rice-based staple food consumption pattern leads to more food waste than wheat-based for university students. As emphasized by Talhelm et al. (2014), Dong et al. (2019), and Zhang et al. (2021), this finding also adds new evidence that individual economic and social behaviors are affected by the rice versus wheat divergence in the north and south of China. It further denotes that this divergence has a significant impact on Chinese behaviors and is an important factor that cannot be ignored.

Other variables, such as gender, education, BMI, food waste knowledge at the individual level, family economic condition at the family-level, catering features such as lunch or dinner, presence of others, plate size, the type of the plate, and food taste satisfaction, and regional factors are also found to significantly impact university students' plate waste (Table 3).

As to individual characteristics, female students have more plate waste than males (Al-Domi et al., 2011). They waste an average of 29.55g less food per capita per meal than male students, and their food waste ratio per capita per meal is about 6% higher than males, indicating the gender influence on food waste, which is in line with studies at Rhodes University in South Africa (Painter et al., 2016). It is also found that postgraduates have a lower amount of plate waste and a higher rate of food waste than undergraduates, suggesting that education helps reduce food waste (Mattar et al., 2018). The results also show that BMI negatively impacts the food waste weights and food-wasting rate, indicating that the students with slim bodies waste more food than those with solid figures (Abdullah et al., 2017; Hawkins et al., 2020).

Furthermore, individuals who are familiar with the disadvantages of wasting food tend to generate less wastage. They have an average of 5.05g less food per capita per meal than those who are less familiar, and

the waste ratio is about 0.8 percentage points lower. It implies that information intervention helps reduce food waste (Ellison et al., 2019; Whitehair et al., 2013; Young et al., 2018). However, it also means that the actual impact of this strategy is very weak, and it is not an effective means to significantly reduce the food wastage generated by Chinese university students.

The results show that family economic conditions positively and significantly impact university students' food waste when it comes to family characteristics. The better the family economic condition is the more food wastage per capita per meal and a higher plate waste ratio. The result validates previous studies (Buzby and Hyman, 2012; Wu et al., 2019).

In terms of catering characteristics, firstly, the university students we surveyed are found to waste more food when they eat lunch rather than dinner, strengthening the studies of Al-Domi et al. (2011) and Marais et al. (2017). Secondly, it is found that "the presence of others" significantly and positively affects university students' food wastage in that the student tends to waste more food when they eat together than alone. It confirms a similar story indicating that young peers substantially impact food consumption and wastage behavior (Lee et al., 2012; Lorenz et al., 2017). Thirdly, the plate size is found to affect food waste generated in university canteens significantly. Larger plate sizes result in more food waste per student per meal and a higher plate waste ratio, consistent with the existing studies' findings (Stancu et al., 2016; Xu et al., 2020).

The difference in "how food is served" is also found to significantly impacts food waste. In the context of Chinese university canteens, there are two popular ways of serving food. One is the "One plate" mode, which puts all the food items (namely, staple food as a main dish and side dish as a subsidiary) into one big plate. Another way is the "separate plates" mode, which provides foods (main and side dishes) on two or more separate plates. Our result shows that the "separate plate" mode can significantly reduce food waste in Chinese universities (Qian et al., 2021). In prior studies, food taste satisfaction significantly impacts individual waste behavior (Lorenz et al., 2017). This paper agrees with Lam et al. (2010) that the more satisfied the student is with food taste, the less wasted food.

As to regional characteristics, Eastern China's regional variable is found to be positively and significantly related to food wastage, indicating that university students study in East China generate more food waste than those in other regions (Non-East-China). On average, students in the east waste 13.60 g more food per capita per meal, and the food waste ratio is 2.6 percentage points higher than their peers in other regions. Given that Eastern China is the most developed region in the country, it makes sense that people in economically developed regions tend to waste more food than less developed ones, as denoted in the literature (Abdelradi, 2018).

3.3. Staple food consumption pattern and food waste: Robust test I

This paper initially finds that the different staple food consumption patterns significantly associate with the food waste differences for university students when dining in canteens. Furthermore, this paper matches the students' "hukou" (China's registration system indicating people's birth/registration place) and the universities' locations to verify the above judgment. The possible four combinations are "Southerners studying in South China", "Southerners studying in North China", "Northerners studying in South China", and "Northerners studying in North China". Setting the "Southerners studying in South China" as the base reference group, three dummy variables are introduced to Eq. (1) to represent the other three groups. The regression results are shown in Table 4.

Table 4. Staple food consumption pattern and food waste: Robust test I.

Variable	Explained variable Weight of food waste (g)	Food waste ratio (%)
Staple food consumption pattern	22.05***	3.56***
	(6.32)	(1.26)
Southerners studying in North China	-18.17***	-3.76***
	(3.35)	(0.66)
Northerners studying in South China	12.30	1.17
	(7.37)	(1.46)
Northerners studying in North China	-0.29**	-0.96**
	(6.74)	(1.34)
Control variables	Yes	Yes
sigma	86.97***	17.26***
	(0.83)	(0.16)
LR chi^2	997.89***	655.72***
Pseudo R^2	0.013	0.012
Observation	8,157	8,166

Note:*$p < 0.1$,** $p < 0.05$,*** $p < 0.01$. The values appearing in parentheses are standard errors. The omitted control variables are consistent with Table 3.

Given that South China's rice-based diet pattern leads to a higher probability of food wastage (in terms of a more plate waste weight and a higher food waste ratio) than North China's wheat-based diet pattern does, it seems reasonable to make the following hypothesis. The Southerners studying in South China universities tend to waste more food than Southerners studying in North China universities. The result shows that (Table 4) the coefficient of "Southerners studying in North China" is negative and significant at 1%, indicating that this cohort tends to waste less food than the reference group. Compared to Southerners studying in South China, Southerners studying in North China generate about 18.17g less food waste per capita per meal, and the food waste ratio is about 3.8 percentage points lower on average. It validates the above hypothesis. Therefore, it is the staple food differences between South and North China that explain food waste variations.

It is also worth noting that the food-wasting behavior of "Northerners studying in South China" is not significantly different from the reference group (Table 4). In other words, when the northerners come to South China, their food-wasting behavior is similar to the Southerners in South China. It implies that no natural difference between the Southerners and Northerners exists. The difference in staple food consumption patterns is the real reason for the food waste variations in the north and south. Specifically, it is the rice-based eating pattern in South China that brings about more food wastage than the North's wheat-based eating pattern.

3.4. Staple food consumption pattern and food waste: Robust test II

There may be a mismatch between the types provided by university canteens and the food that the students prefer, which may lead to differentiated food wastage between the north and the south. However, the

mismatch phenomenon may not be very common in Chinese universities. This study divides food waste into 10 categories; and an important reason is that they are the main types of the Chinese diet, which are very prevalent in university canteens countrywide. Moreover, considering that university students usually come from different provinces of China, Chinese university canteens generally provide diversified diets to meet students' food needs and tastes as much as possible. The foods provided include northerners' favourites and southerners' favourites. Representative foods from different provinces or specific diets for minorities can also be found in Chinese university canteens. As a result, university students can choose what to eat accordingly. In addition, we found that a Chinese university usually has many canteens, and students can eat their preferred food at their favorite canteens. Therefore, the mismatch is not a severe issue in the Chinese context.

Another concern is that there may be systemic differences between university students. In addition to the difference in staple food consumption patterns, an implicit assumption of the above models in Tables 3 and 4 is that systematic differences do not exist between university students. However, there may be differences in many aspects between university students in the south and their peers in the north, including the features at the individual level (e.g., BMI), family level (e.g., family economic condition), and dining characteristics (e.g., food taste satisfaction). Considering that there are also differences in other dimensional characteristics of individuals in the north and south, this may lead to selectivity bias.

Although we believe that the selectivity bias is not very serious in Chinese universities, to solve this possible problem effectively, this paper still introduces the Propensity Scoring Method (PSM) proposed by Rosenbaum and Rubin (1983). The basic idea of PSM is as follows: for each individual i in the experimental group, we match it with an individual j in the control group. Except for the inconsistency of key variables, the characteristics of i and j are as similar as possible in other aspects, just like an individual i has a twin individual j in the control group (Rosenbaum and Rubin, 1983). Thus, through the matching method, the difference between the control group (northerners who are wheat-based eaters) and the experimental group (southerners who are rice-based eaters) will be significantly reduced.

The commonly used matching methods of PSM include the nearest neighbour matching, radius matching, and kernel matching. After matching, the impacts of staple food consumption patterns on individual food waste are shown in Table 5. The results suggest that even if the selection bias is effectively resolved[7], staple food consumption pattern still significantly positively affects individual food waste, showing that university students in the south waste more food than university students in the north. It confirms that the difference in staple food consumption patterns is the key reason that southerners waste more food than northerners in university canteens. Combining the three kinds of matching methods (Table 5), it is not difficult to find that Southerners who consume rice as their staple food generate about 15g more wastage per capita per meal than Northerners who are wheat-based eaters, and the food waste ratio per capita per meal of Southerners is about 3% higher than Northerners, which are very close to the estimations in the benchmark regression.

Table 5. Staple food consumption pattern and food waste: Robust test II based on PSM.

Matching method	Average treatment effect (ATT) Weight of food waste (g) Food waste ratio (%)	
Nearest neighbour matching (1:1)	15.22*** (2.30)	2.82*** (0.43)
Radius matching (0.01)	15.29*** (1.78)	3.23*** (0.35)
Kernel matching	15.72*** (1.78)	3.37*** (0.34)

Note:*$p < 0.1$,** $p < 0.05$,*** $p < 0.01$. The values appearing in parentheses are standard errors.

4. Discussion

4.1. Food waste generation

This paper investigates food waste issues at the Chinese university canteens based on a large-scale national survey. It is calculated that the average amount of plate waste per student per meal is about 61 grams, which is slightly lower than the result of 73.7 grams based on the study of six universities in Beijing (Wu et al., 2019). It may be because the survey of Wu et al. (2019) takes place in Beijing, China's capital city, where the economic development level is above the average of China. While Beijing is an economically developed megacity, it is reasonable that Beijing's plate waste issue is more severe than that of other places. Compared to the survey in Beijing, this paper's conclusions are based on the national survey; therefore, the data is more representative of the plate waste situation in Chinese universities.

Also, three are some characteristic findings when compared with other Chinese consumer food waste studies. Firstly, university students' food waste in university canteens is less than in restaurants. For example, Wang et al. (2017) found that consumers waste 93 grams of food per capita per meal when dining in restaurants, based on a survey of 195 restaurants in four cities in China. Xu et al.'s (2020) report 172.3 grams of food is wasted per capita per meal and 18% of the food-wasting rate per capita per meal, based on a survey of 171 restaurants in Beijing and Lhasa. Secondly, food wastage in university canteens is a more severe issue than in households. For example, Jiang et al. (2018) find that on average, only 29 grams of edible food is wasted per capita per meal at home, and 3%-5% of food is wasted from 1991 to 2009 based on the China Nutrition and Health Survey (CHNS) data. Similarly, Min et al., (2021) conclude that the household food waste weight per capita per day is 42.56 grams, based on CHNS2004, CHNS2006, and CHNS2009 survey data. Based on a survey of 207 Chinese rural residents, Li et al. (2021) found rural households generated only 8.74 g of food wastage per capita per meal. Therefore, this study argues that Chinese university students waste more food in university canteens than at home, but less than in restaurants.

Thirdly, Chinese university students seem to waste less food than their peers in western universities. The survey shows that, on average, Southerners who are rice-based eaters waste more food than Northerners who are wheat-based eaters. The food waste weights are 68.56 grams for Southerners and 53.88 grams for Northerners per capita per meal. However, Graunke and Wilkie (2008) find that university students in the USA waste about 444 grams of food waste per capita per meal. Pinto et al. (2018) report that university students generate about 458 grams of food waste per capita per meal in the University of Lisbon, Portugal. Besides, Painter et al. (2016) reveal that South African university students waste 555 grams (including three meals) per student per day. Therefore, this study claims that university food waste issues in western developed countries are more severe than those at Chinese universities. There are two reasons behind the large gap in the food waste scale between Chinese and Western university students. The first is the difference between China's economic development levels and the developed countries in the West. Many studies show that the higher the income level of an individual or family is (Buzby and

Hyman, 2012; Stancu et al., 2016), the more food is wasted. When China's standard of living is still much lower than that of developed countries, Chinese university students waste less food. Secondly, the gap in the amount of food wasted by Chinese and Western university students may be due to the significant differences between Chinese and Western countries' diets. Compared with the difference in staple food consumption patterns between South and North China, the differences in ingredients, cooking methods, and other aspects between Chinese and Western diets are even more significant. However, this guess is yet to be validated by future transnational studies.

4.2. Staple food consumption pattern and the composition of food waste

This paper finds that Chinese Southerners who are rice-based eaters tend to waste more food than Northerners who are wheat-based eaters, using Chinese university students dining in university canteens as an example. Through descriptive analysis, benchmark regression, robustness tests I and II, this study indicates that the difference in staple food consumption patterns between South and North China elucidates why rice-based ones waste more food on average. We believe that the finding that the difference in dietary culture has a significant impact on the food wastage of Chinese university students is robust. However, this paper wants to go further and provide more evidence. The subsequent analysis will firstly analyze the food items purchased by the individuals. Then, the two sample t-test is used to further compare the composition of Southerners and Northerners' food wastage.

It is assumed that there are significant differences in staple food consumption patterns between the north and south of China. This assumption is the prerequisite for the empirical analysis in this study. However, is this common sense true for Chinese university students? No study has tested this judgment before. Based on the standard weight we purchased before meals, it is not difficult to infer the composition of food consumed by university students before meals on average. The results (Fig. 2) show that only the two types of staple foods (rice and wheat) had passed the t-test at the 1% significance level, and there is no significant difference ($p<0.5$) in other food items among students in the south and north. That is to say, the difference in diet culture between North China and South China is mainly reflected in staple food consumption pattern differences. As far as we know, the paper provides the first verification on diet culture in China. The finding in Fig. 2 means that the setting of the core explanatory variables in this paper is reasonable (1=southerners who are rice-based eaters, 0=northerners who are wheat-based eaters), and the core findings drawn from Table 2, Table 3, Table 4, Table 5 are credible.

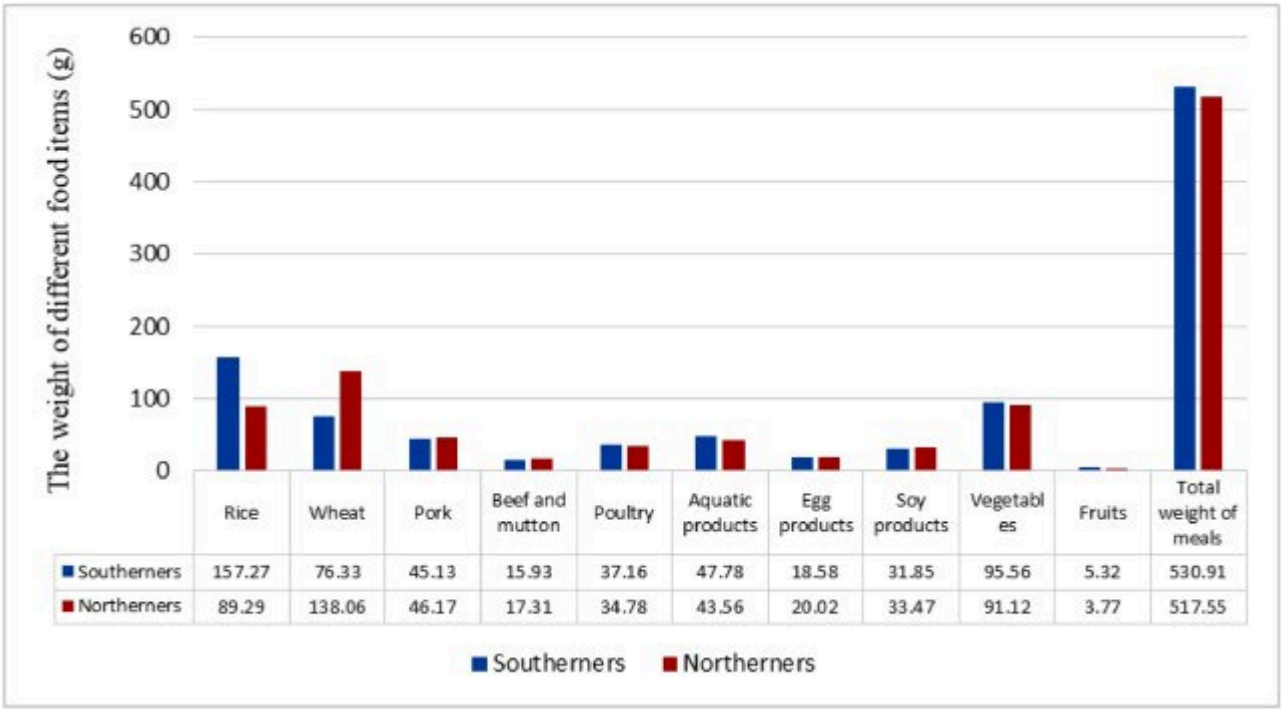

Fig. 2. The composition of food consumption in the north and south.

We continue to compare the composition of food wastage of university students in the north and south. Fig. 3 shows that the most wasted food components are stapled foods and vegetables, whether for southerners or northerners (accounting for 60% of food wastage). On average, Southerners generate 14.68 grams of food waste more than Northerners per capita per meal. The two sample t-test is also used to compare the composition of food waste between the two groups. On average, university students in southern China (17.25g) waste more rice per capita per meal than university students in northern China (7.93g), and this difference passed the 1% significance level t-test ($t=-9.70$). And a two sample t-test ($t=-5.48$) with a 95% confidence interval ($p<0.05$) shows that Northerners (16.35g) waste more wheat than Southerners (11.87g). However, for other food items, the differences in wastage between the South and the North are not significant, and none of them passed the t-test with a 95% confidence interval ($p<0.05$). Therefore, it further shows that the rice versus wheat divergence is the key to food waste composition between Southerners and Northerners, and the difference in staple food consumption patterns determines the food waste between the South and North has been further confirmed.

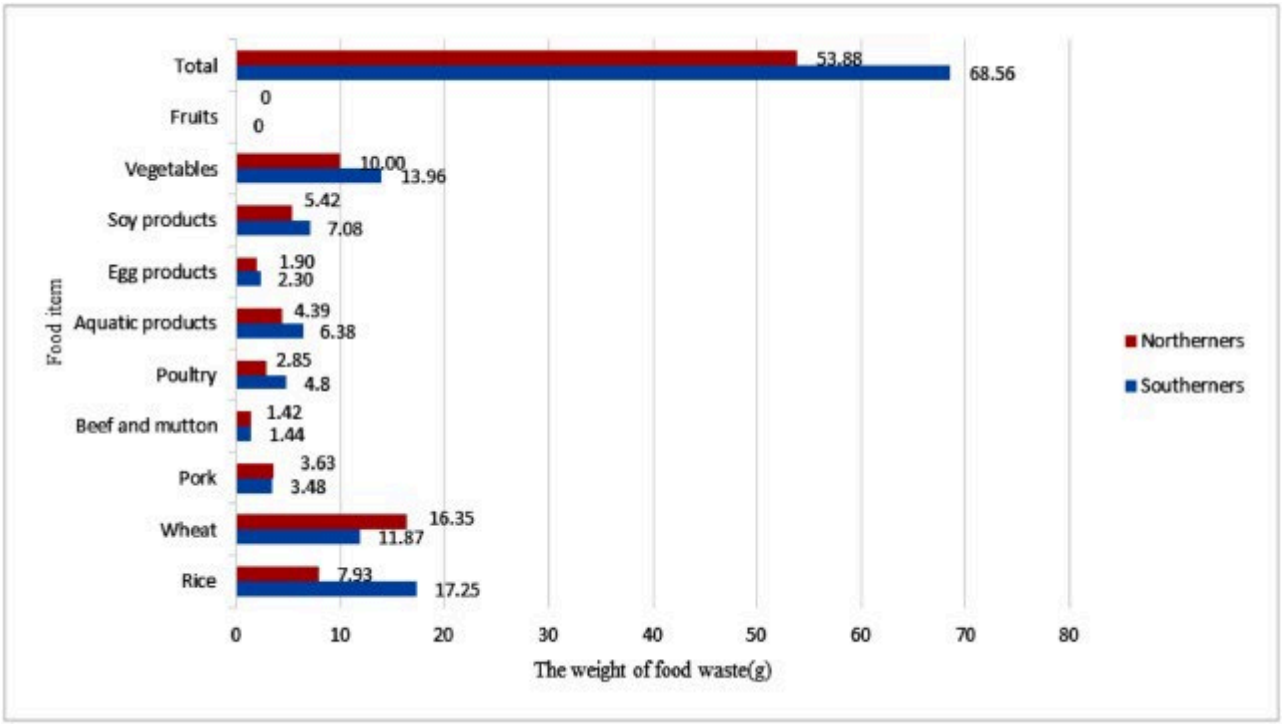

Fig. 3. The composition of food waste among southerners and northerners.

In summary, this paper use multiple forms of verification from different disciplines makes the core finding more credible, and the multidiscipline perspective is one of the advantages of this paper. The core finding that the difference in staple food consumption patterns between South and North China is responsible for discrepancies in food wastage is very robust. Compared with previous studies on transnational diet culture (Secondi et al., 2015; Ferk et al., 2018), this paper is among the first attempts to rigorously provide evidence that differences in diet culture within a country impact individual food waste.

4.3. Potential implications

With China's economic development and improvement in people's living standards, food waste becomes an urgent issue (Min et al., 2021; Wang et al., 2017; Xu et al., 2020). This study attempts to explain university students' food wastage from the dietary patterns perspectives, for such research is rare in developing China. It implies that university students in South China who consume rice as the staple food waste more food than their peers in the North who are wheat-based eaters when dining in university canteens. The rice-based diet pattern is found to be responsible for the extra food waste. Moreover, university students' food-wasting performance is also affected by individual characteristics, family characteristics, and dining characteristics. Therefore, the following impactions or targeted mitigation strategies are proposed.

First, this study finds that the different staple food consumption patterns between South and North China significantly associate with university students' food wastage. The rice-eating diet in South China causes more food waste than the wheat-eating diet in the North in Chinese university canteens. It is not our intention to compare diet superiority in this paper. The mainstream dietary patterns in South and North China result from thousands of years' development under a combined influence of history, culture, climate, and geography. Therefore, it is not easy to change the eating habit in the short run and impossible to ask Southerners to eat wheat to save more food. However, the above findings still provide some enlightenment for reducing food waste in university canteens. Since the rice-based diet leads to more food waste, reducing the supply of rice on the plate seems to be a feasible measure for rice-based eaters. With the improvement of living standards, the daily diet is more diversified for the Chinese (Bai et al., 2016), and the demand for staple food declines. The survey also confirmed that the main reason why students wasted staple foods is mainly that it exceeds their actual needs. The university canteens can appropriately reduce the standard

weight of rice and provide smaller portions for students. Moreover, diversifying staple foods may be another measure to reduce food waste. Although southerners still prefer rice, what is encouraging is that with more migration and cultural exchange, the daily intake of flour products in Southerner's diet has recently increased, which may help reduce food waste. It is yet to be confirmed by future follow-up research. Finally, the core findings of this paper may help inspire follow-up research. Scholars in other countries can also explore how the regional differences in diet culture affect individual food waste, especially for those countries with diversified staple food patterns. Moreover, this paper provides new evidence that the rice versus wheat divergence in the north and south of China has a significant impact on an individual's economic and social behavior (Talhelm, 2020; Zhang et al., 2021), which is of help to expand the scope of related studies.

Second, the individual characteristics of students have a significant impact on food waste. For example, this study finds that female students waste more food than males; the education level and the BMI of individuals also affect food waste. As a result, it is suggested that the university canteens pay more attention to those who tend to waste more food. For example, for females and slimmer youth, universities need to investigate in depth why female students and the slim generate more plate waste. If the food supply exceeds their needs, then provide them with smaller meals; if it is because of deliberately reducing intake to lose weight, they need to be guided to form a reasonable health value. Besides, it is found that a higher frequency of exposure to food-saving campaigns helps to reduce food waste. However, the actual effect of this measure is not good, and Chinese universities need to reflect and find out how to reduce food waste in university canteens by information intervention.

Third, for family features, the study reveals the positive association between family economic conditions and plate waste, warning us that without interventions, further improvement in family economic conditions may lead to more food waste in future China. It is predicted that China's GDP will become the world's largest economy in the near future (Kolodko, 2020), and the number of students enrolled in Chinese universities will continue to grow (MEC, 2020). If there is no intervention, the total scale of wastage will further increase and be very staggering. China is very likely to play a critical role in determining global food waste. Fortunately, the Chinese government has realized the importance of reducing food waste and officially passed the Anti-Food Waste Law in April 2021, setting out specific regulations to reduce food waste in colleges and universities. However, how this law impacts the food waste of university students is yet to be explored by follow-up research.

Fourth, catering characteristics have critical influences on individual food wastage. The finding that university students tend to waste more food during lunch than dinner may be due to the short lunch break in the Chinese context, indicating that rearranging class to allow a more extended lunchtime may reduce food waste. Plate size and food waste are significantly positively correlated. Therefore, to reduce food waste effectively, university canteens should remind university students to purchase meals reasonably and provide smaller portion sizes to meet their demand for rich diets (Xu et al., 2020). Also, it is found that peers have a positive impact on an individual's food-waste performance. It may be due to two reasons: one is that food has a distinct function of communication in Chinese culture; the other is that ordering more than enough food in front of others is considered a sign of generosity and wealth. It is recommended to carry out an in-depth investigation and research to find out the real reasons why university students waste more food when eating together to reduce food waste effectively. This paper reveals that students waste more food if staple food and side dishes are served on a single plate. This may be because when different foods are placed on a single plate, possibly the mixed flavors make the meal less tasty than that in a “separate mode”. Therefore, it is recommended that university canteens can provide staple food and side dishes on separate plates to reduce food waste. Subjective taste evaluation is also closely related to food waste. The more an individual satisfy with the food taste, the less food waste. Therefore, it is recommended that university canteens improve food taste, strengthen communication with students, and provide delicious dishes to reduce food waste (Lorenz et al., 2017).

4.4. Limitations

There are still some limitations to this research. This study interprets food wastage differences among Chinese university students from the perspective of different staple food consumption patterns between South and North China.

However, there are also great diversities in diets within South and North China, respectively. For example, seven of the eight major Chinese cuisines are from South China. Therefore, future research studying how differences in diet in different provinces affect individual food wastage is needed. Secondly, the study investigated young university students dining in canteens only. Whether non-university students' food wastage follows the same pattern? Do Southerners who are rice-based eaters still waste more food than Northerners who consume wheat as their staple food at other places, such as home or restaurants? Those questions still need to be answered and tested by follow-up research.

5. Conclusion

This study investigates food waste in Chinese university canteens to better understand the factors influencing Chinese university students' food-wasting behavior. The paper tries to explain individual plate waste from the perspective of diet culture. The two sample t-test shows that the difference in diet culture between North China and South China is mainly reflected in staple food differences. The t-test for group analysis and the benchmark regression show that the difference in staple food consumption patterns significantly impacts an individual's food wastage when dining in university canteens. Southerners who are rice-based eaters are found to waste more food on average, and they also have a higher rate of plate waste than Northerners who are wheat-based eaters. The robustness tests also prove that the staple food consumption patterns associate with individual food wastage in Chinese canteens. The composition of food wastage further reveals that the difference in staple food consumption patterns in the north and south is the key reason for the differentiated food waste among Chinese university students. To sum up, this paper provides new empirical evidence that individuals of different regions within a country have differentiated food waste behavior due to dietary patterns, thus enriching the body of literature.

CRediT authorship contribution statement

Long Qian: Conceptualization, Methodology, Software, Writing – original draft, Writing – review & editing. **Feng Li:** Investigation, Data curation. **Hongbo Liu:** Conceptualization, Writing – review & editing. **Lingen Wang:** Methodology, Validation. **Breda McCarthy:** Supervision. **Shaosheng Jin:** Supervision, Writing – review & editing, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Endnotes

[1] The Qinling–Huaihe Line is a reference line used by geographers to distinguish between northern and southern China, corresponding roughly to the 33rd parallel. Qinling refers to the Qin Mountains, and Huaihe refers to the Huai River.
[2] The authors declare that the investigation on food waste in Chinese universities does not require the ethics committee's approval. This investigation does not include individually identifiable data. The respondents can stop answering questions at any time during the interview stage without explanation or prejudice. The investigation strictly followed and was abided by Chinese laws and regulations.
[3] For detail, please refer to the study of Qian et al. (2021), who has used the same data and attached the questionnaire to the appendix.
[4] There may be a concern that different universities serve different meals in canteens, resulting in differences in individual food waste. However, those 10 categories are the main types of the Chinese diet, which are very common in Chinese university canteens. There may be differences in the form, but the choices of ingredients are roughly the same.
[5] The scale of Chinese universities is generally large, with an average of about 13,000 university students enrolled (MEC, 2020). Therefore, without loss of generality, we assume that each university has an average of 15,000 students. When we require the sampling sample to achieve overall confidence of 95% and the maximum allowable error to be kept within 5%, the minimum sample size of each university only needs to reach about 150 people. However, to increase the representativeness of the sampled data as much as possible, we actively increased the workload and set the minimum sample size to 300 in the universities surveyed. For universities with a larger number of students, the minimum sample size is set to 350.
[6] There is an academic consensus that 15 provinces, including Sichuan, Yunnan, Chongqing, Guizhou, Guangxi, Hubei, Hunan, Anhui, Jiangsu, Shanghai, Zhejiang, Jiangxi, Fujian, Guangdong, and Hainan, are classified as south China. Another 14 provinces, including Heilongjiang, Jilin, Liaoning, Inner Mongolia, Xinjiang, Gansu, Qinghai, Ningxia, Shaanxi, Shanxi, Hebei, Beijing, Tianjin, and Shandong classified as north China.
[7] The test for the common support domain shows that it is suitable to use PSM in this paper, and most of the characteristic differences between the two groups are reduced to less than 5% which means that the matching effect is very good.

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